Assembly Instructions MP-8M Memory Board

Introduction

The MP-8M Memory Board is a 5 1/2" x 9" double sided plated thru hole board with a total storage capability of 8,192 (8K) words of a 8 bit random asscess memory. The circuitry on the board provides all of the address decoding and data line buffering to handle a total of 16 4K (4K bit x 1 bit) static random access memory integrated circuits. All interconnections to the system are made via a 50 pin connector to the Mother Board (MP-B). +5 volt power for the board is supplied by two on board regulators. Current consumption for the entire board (8K of memory plus decoder/buffer) is approximately 1.5 amp.

When the SWTPC 6800 Computer System is being assembled, work on only one board at a time. Each of the system's boards and their associated parts must not be intermixed to avoid confusion during assembly. The MOS integrated circuits supplied with this kit are susceptible to static electricity damage and for this reason have been packed with their leads impressed onto a special conductive foam or possible wrapped in a conductive foil. In either case, do not remove the protective material until specifically told to do so later in the instructions.

PC Board Assembly

Note: Since all of the holes on the PC board have been plated thru, it is only necessary to solder the components from the bottom side of the board. The plating provides the electrical connection from the "BOTTOM" to the "TOP" foil of each hole. Unless otherwise noted it is important that none of the connections be soldered until all of the components of each group have been installed on the board. This makes it much easier to interchange components if a mistake is made during assembly. Do not use acid core solder or any type of paste flux. We will not guarantee or repair any kit on which either product has been used. Use only the solder supplied with the kit or a 60/40 alloy resin core equivalent. Remember all of the connections are soldered on the bottom side of the board only. The plated thru holes provide the electrical connection to the top foil.

( ) Before installing any parts on the circuit board, check both sides of the board over carefully for incomplete etching and foil "bridges" or "breaks". It is unlikely that you will find any but should there be one especially on the "TOP" side of the board it will be very hard to locate and correct after all of the components have been installed on the board.

( ) Attach all of the resistors to the board. As with all other components unless noted, use the parts list and component layout drawing to locate each part and install from the "TOP" side of the board bending the leads along the "BOTTOM" side of the board and trimming so that 1/16" to 1/8" of wire remains. Solder.

( ) Install all of the capacitors on the board. Be sure to orient the electrolytic capacitor correctly. The polarity is indicated on the component layout drawing. Solder.

( ) Starting from one end of the circuit board install each of the five, 10 pin Molex female edge connectors along the lower edge of the board. These connectors must be inserted from the "TOP" side of the board and must be pressed down firmly against the board. Make sure the body of the connector seats firmly against the circuit board and that each pin extends completely into the holes on the circuit board. Not being careful here will cause the board to either wobble and/or be crooked when plugged onto the mother board. It is suggested that you solder only the two end pins of each of the five connectors until all have been installed at which time if everything looks straight and rigid you should solder the as yet unsoldered pins.

( ) Insert the small nylon indexing plug into the edge connector pin indicated by the small triangular arrow on the "BOTTOM" side of the circuit board. This prevents the board from being accidentally plugged onto the mother board incorrectly.

( ) Install switches S1 and S2 on the circuit board. Be sure to install switch S2 so the switches are ON when the paddles are nearer the TOP edge of the MP-8M circuit board. Solder.

( ) Install integrated circuits IC16 thru IC22. As each one is installed make sure it is down firmly against the board and solder only two of the leads to hold the pack in place while the other IC's are being inserted. Be very careful to install each in its correct position. Do not bend the leads on the back side of the board. Doing so makes it very difficult to remove the integrated circuits should replacement ever be necessary. The semicircle notch or dot on the end of the package is used for orientation purposes and must match with the outlines shown on the component layout drawing for each of the IC's. After inserting all of the integrated circuits go back and solder each of the as yet unsoldered pins.

( ) Cut off the center lead of integrated circuits IC23 and IC24 using a pair of wire cutters.

( ) Install integrated circuits IC23 and IC24 on the circuit board. These components must be oriented so their metal face is facing the circuit board with the small metal heatsink sandwiched between the two on both. The heatsink and IC are secured to the circuit board with a #4-40 x 1/4" screw, lockwasher and nut. The two leads of the integrated circuit must be oriented as shown in the component layout drawing. Solder.

NOTE: MOS integrated circuits are susceptable to damage by static electricity. Although some degree of protection is provided internally within the integrated circuits, their cost demands the utmost in care. Before opening and/or installing any MOS integrated circuits you should ground your body and all metallic tools coming into contact with the leads, thru a 1 M Ω 1/4 watt resistor (supplied with the kit). The ground must be an "earth" ground such as a water pipe, and not the circuit board ground.

As for the connection to your body, attach a clip lead to your watch or metal ID bracelet. Make absolutely sure you have the 1 Meg ohm resistor connected between you and the "earth" ground, otherwise you will be creating a dangerous shock hazard. Avoid touching the leads of the integrated circuits any more than necessary when installing them, even if you are grounded. On those MOS IC's being soldered in place; the tip of the soldering iron should be grounded as well (separately from your body ground) either with or without a 1 Meg ohm resistor. Most soldering irons having a three prong line cord plug already have a grounded tip. Static electricity should be an important consideration in cold, dry environments. It is less of a problem when it is warm and humid.

( ) Install MOS integrated circuits IC0 thru IC15 following the precautions given in the preceding section. As each is installed, make sure it is down firmly against the board before soldering all of its leads. Be very careful to install each in its correct position. Do not bend the leads on the back side of the board. Doing so makes it very difficult to remove the integrated circuits should replacement ever be necessary. The "dot" or "notch" on the end of the package is used for orientation purposes and must match with that shown on the component layout drawing for each of the IC's.

( ) Now that all of the components have been installed on the board, double check to make sure that all have been installed correctly in their proper location.

( ) Check very carefully to make sure that all connections have been soldered. It is very easy to miss some connections when soldering which can really cause some hard to find problems later during check out. Also look for solder "bridges" and "cold" solder joints which are another common problem.

This completes the assembly of the MP-8M board. Since the circuit board now contains MOS devices it is susceptable to damage from severe static electrical sources. One should avoid handling the board any more than necessary and when you must, avoid touching or allowing ANYTHING to come into contact with any of the conductors on the board.

MP-8M Memory Board Checkout Procedure

NOTE: Before checking out the MP-8M memory board, it must be switch programmed for the proper address selection using switch S2. To set the switches, initially set all of the switches off. To program the board for the 0-8K range, flip the switch adjacent the number 16 ON; for the 8K-16K range, flip the switch adjacent the number 16 ON; for the 16K-24K range, flip the switch adjacent the number 24 ON; for the 24K-32K range, flip the switch adjacent the number 32 ON. Only one switch may be ON at a time otherwise the board will respond to more than one range of addresses. Make sure the WRITE PROTECT switch, S1, is in the NORMAL position. If you have MP-M memory boards in your system, you may have to reconfigure the MP-M boards so their address decoding does not conflict with those addresses assigned to the MP-8M memory boards. You should program your memory boards so your system has continuous memory starting from location 0000; going as high as your memory supply allows. Use the MP-8M boards for your low memory and the MP-M board for upper memory.

32K of memory is the maximum you may have in the SWTPC 6800 Computer System. Just for your own information the MP-8M memory board consumes about the same power as a fully expanded MP-M board while providing twice as much memory.

( ) Set the selected address switch as described before.

( ) Remove the system's AC power if applied.

( ) Check over the MP-8M Memory board to see that all connections have been soldered and that there are no solder or foil conductor "bridges" or "breaks".

( ) Looking at the MP-B Mother board from the front of the chassis and with the MP-8M Memory board oriented so you are viewing the "TOP" side, set the board down lightly on one of the connector rows of the mother board. Electrically the board may be plugged onto any one of the seven main board positions. Check to see that the index pin on both the MP-B board and the MP-8M board align. They should align, if not, there is a mistake.

( ) Assuming the index pin aligns, press the MP-8M board down perpendicularly onto the mother board. Be sure the MP-8M board seats firmly against the mother board.

( ) Again apply AC power to the unit. Using one of the GND pins on the mother board as a reference, measure the voltage on the right most lead of the voltage regulators IC23 and IC24 on the MP-8M board. The reading should be +5 VDC $\pm$5%. If not, something is wrong.

( ) Enter and run the ROBIT and MEMCON memory diagnostic programs listed in the software section of the System Documentation Notebook. Use the tables listed at the end of this instruction set to determine the proper starting and ending memory addresses to be entered for the programs. For example, if the memory board to be tested is board address selected for the 0 to 8K range, then the lowest address on the board is 0000 and the highest address is 1FFF. If either of the programs indicate errors, you can re-run the diagnostics on 4,096 word increments of memory to help pinpoint the source of the problem. There is always the chance of a bad IC but experience has shown that most problems will be the result of a solder or foil conductor "bridge" or "break". So get out the magnifying glass and check the board over very carefully if you have a problem. The most thorough memory diagnostic available at the time of this writing is CDAT-1. A copy of this diagnostic is being included in this instruction set.

Write Protect Feature

The MP-8M memory board is provided with a write protect switch which allows the user to prevent the contents of the entire memory board from being changed once the switch has been flipped to the PROTECT position. The contents of memory will still be lost of course if and when the system is ever powered down. Since the write protect feature is rarely used, you will normally operate the board with the write protect switch in the NORMAL position.

How It Works

Each of the memory chips on the board is a 1 x 4096 bit static random access memory IC storing one of the eight bits of each word within one of the two, 4,096 word memory halves. The actual bit and half assignment of each memory IC is given in the table at the end of this instruction set. The twelve address lines A_0 thru A_{11}, as well as the R/W lines of all of the memory IC's on each board are paralleled. Because of the large capacitances generated by this paralleling, integrated circuits IC19 and IC20 are used as non-inverting buffers to drive the forementioned lines. The actual address selection for each of the two eight bit 4,096 word halves is done using integrated circuits IC18, IC21 and IC22.

Since the eight bit data buss for the computer system is bi-directional, bi-directional transceiver/buffers IC16 and IC17 buffer the incoming and outgoing data to and from the memory board to the data buss. Integrated circuits IC21 and IC22 enable the outgoing sections of the bi-directional transceivers at the appropriate times while the incoming sections of the bi-directional transceivers are enabled at all times since the memory IC's have separate input/output lines. +5 volt power for the decoders and buffers (IC16 - IC22) is supplied by voltage regulator IC23 while +5 volt power for the memories is supplied by voltage regulator IC24. The various capacitors are used on the board to reduce power supply buss noise.

MP-8M Memory Address Assignment Table (hex)

Board Select	Half of Memory	Starting Address	Ending Address
8	lower	0000	0FFF
	upper	1000	1FFF
16	lower	2000	2FFF
	upper	3000	3FFF
24	lower	4000	4FFF
	upper	5000	5FFF
32	lower	6000	6FFF
	upper	7000	7FFF

MP-8M Memory IC Assignment Table

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Lower 4K	IC 7	IC 6	IC 5	IC 4	IC 3	IC 2	IC 1	IC 0
Upper 4K	IC15	IC 14	IC 13	IC 12	IC 11	IC 10	IC 9	IC 8

Hex to Binary Conversion

00 hex = 0000 0000 binary
01 hex = 0000 0001 binary
02 hex = 0000 0010 binary
04 hex = 0000 0100 binary
08 hex = 0000 1000 binary
10 hex = 0001 0000 binary
20 hex = 0010 0000 binary
40 hex = 0100 0000 binary
80 hex = 1000 0000 binary

Parts List MP-8M Memory Board

Resistors

___	R1	1K ohm 1/4 watt resistor
___	R2	" " " " "

Capacitors

___	C1	Ø.1 mfd capacitor
___	C2	" " "
___	C3	" " "
___	C4	" " "
___	C5	" " "
___	C6	" " "
___	C7	" " "
___	C8*	1ØØ mfd @ 16 VDC electrolytic capacitor

Integrated Circuits

___	ICØ*	TMS4044 4K x 1 static memory or equiv.
___	IC1*	" " " " " " " "
___	IC2*	" " " " " " " "
___	IC3*	" " " " " " " "
___	IC4*	" " " " " " " "
___	IC5*	" " " " " " " "
___	IC6*	" " " " " " " "
___	IC7*	" " " " " " " "
___	IC8*	" " " " " " " "
___	IC9*	" " " " " " " "
___	IC1Ø*	" " " " " " " "
___	IC11*	" " " " " " " "
___	IC12*	" " " " " " " "
___	IC13*	" " " " " " " "
___	IC14*	" " " " " " " "
___	IC15*	" " " " " " " "
___	IC16*	DM8835 bi-directional transceiver
___	IC17*	" " "
___	IC18*	74S138 decoder
___	IC19*	DM8097 or 74367 buffer
___	IC2Ø*	" " " "
___	IC21*	7400 quad NAND gate
___	IC22*	7410 triple NAND gate
___	IC23*	7805 5 VDC voltage regulator
___	IC24*	" " " " "

Switches

___	S1*	SPDT mineature toggle switch
___	S2*	4 position DIP switch

Dual Address Memory Test CDAT-2
Modified for MIKBUG® or SWTBUG® Operation

By John Christensen

The CDAT memory diagnostic can be used to help locate memory problems in a SWTPC 6800 Computer System that MEMCON and ROBIT may miss. The program itself resides entirely within the 128 byte SWTBUG® RAM. The program must be loaded in two parts to avoid interfering with the system's push down stack. The contiguous section of memory to be tested is set by loading the most significant byte of the lower memory address into AØØ2, the least significant byte into AØØ3, the most significant byte of the upper memory address in AØØ4 and its least significant byte in AØØ5. The low address must be less than or equal to the upper address.

The test starts from the low address and writes a ØØ into all memory up to the high address. An FF is then written into the first address and all other locations are checked to be sure they contain ØØ. If all are OK the FF is replaced with a ØØ and an FF is written in the next memory location. This pattern continues until all memory is checked or until an error is found. If the computer returns to SWTBUG®, then no errors were found.

If the program displays a register dump, then a problem was discovered on the board. The register dump should look similar to the following:

```
          ADDRESS        ERROR MSG.
          └─────┘        ┌─────┘
F3 00 FF 0400 A079 A042
```

The important parts of the dump are the ADDRESS and the ERROR MSG. areas, as denoted above. The error messages are interpreted as follows:

AØ77	Error on initial test pattern (can't write Ø's into mem.)
AØ78	Error on second test pattern (can't write FF's into mem.)
AØ79	Dual address error low
AØ7A	Dual address error high

If a dual address error is found, then writing into one memory location affects another. For example, if ADDRESS =Ø4ØØ and AØ14 contains Ø41Ø then writing into Ø4ØØ will change the contents of Ø41Ø or vice-versa. (AØ14 is a temporary index register storage location within the program that you can compare with ADDRESS in the register dump to see which two memory locations caused the error). The IC assignments table included with the memory board instructions can then be used to help locate the problem by comparing the bit pattern of the locations in error.

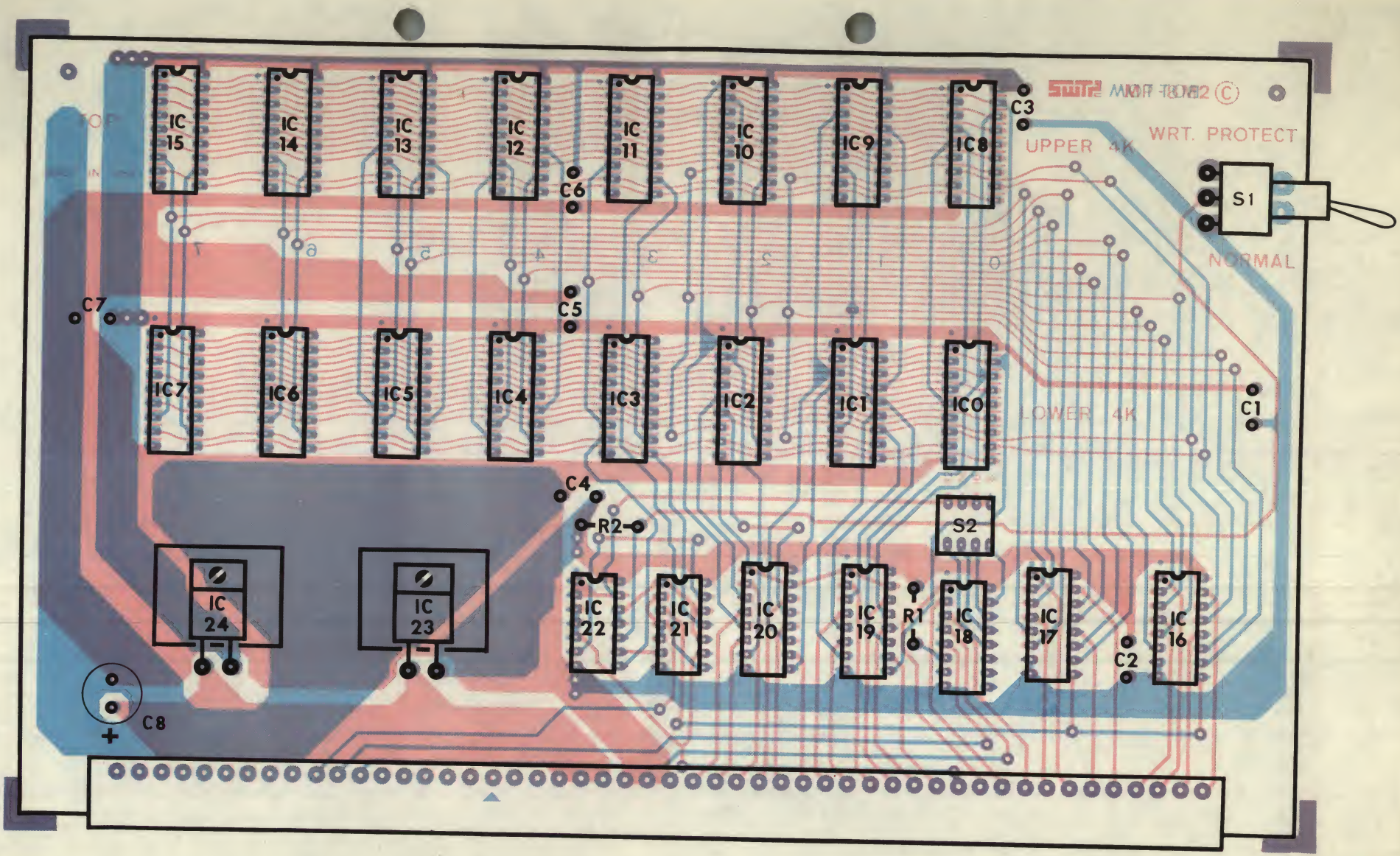
The CDAT program takes some time to run, so run the diagnostic over only one complete board at a time.

MEM. SIZE	APPROX. RUN TIME
1K	29 sec.
2K	1 min. 53 sec.
3K	4 min. 13 sec.
4K	7 min. 29 sec.
8K	more than 30 min.

```
                                NAM     CDAT-2
                        *MEMORY DIAGNOSTIC (JOHN CHRISTENSEN'S)
                        *MODIFIED FOR MIKBUG AND SWTBUG OPERATION
E0E3                    CONTRL  EQU     $E0E3
A002                            ORG     $A002
A002                    LOTEMP  RMB     2           STARTING ADDRESS
A004                    HITEMP  RMB     2           ENDING ADDRESS
A014                            ORG     $A014
A014                    IXRTMP  RMB     2           IXR TEMPORARY STORAGE
A016 FE A0 02           START   LDX     LOTEMP
A019 B6 A0 7E                   LDA A   INIPAT
A01C A7 00              LOOP1   STA A   0,X
A01E A1 00                      CMP A   0,X
A020 26 55                      BNE     ERPNT1
A022 BC A0 04                   CPX     HITEMP
A025 27 03                      BEQ     LOAPAT
A027 08                         INX
A028 20 F2                      BRA     LOOP1
A02A FE A0 02           LOAPAT  LDX     LOTEMP
A02D F6 A0 7F                   LDA B   TESPAT
A030 E7 00              LOOP4   STA B   0,X
A032 20 16                      BRA     CHECK

A048                            ORG     $A048
A048 A0 16                      FDB     START
A04A E1 00              CHECK   CMP B   0,X
A04C 26 2A                      BNE     ERPNT2
A04E FF A0 14           CHKLOW  STX     IXRTMP
A051 BC A0 02           LOOP2   CPX     LOTEMP
A054 27 07                      BEQ     CHCKHI
A056 09                         DEX
A057 A1 00                      CMP A   0,X
A059 26 1E                      BNE     ERPNT3
A05B 20 F4                      BRA     LOOP2
A05D FE A0 14           CHCKHI  LDX     IXRTMP
A060 BC A0 04                   CPX     HITEMP
A063 27 16                      BEQ     END
A065 08                 LOOP3   INX
A066 A1 00                      CMP A   0,X
A068 26 10                      BNE     ERPNT4
A06A BC A0 04                   CPX     HITEMP
A06D 26 F6                      BNE     LOOP3
A06F FE A0 14           RESTRE  LDX     IXRTMP
A072 A7 00                      STA A   0,X
A074 08                         INX
A075 20 B9                      BRA     LOOP4
A077 3F                 ERPNT1  SWI             ERROR ON INITIAL PATTERN
A078 3F                 ERPNT2  SWI             ERROR ON TEST PATTERN
A079 3F                 ERPNT3  SWI             DUAL ADDRESS ERROR LOW
A07A 3F                 ERPNT4  SWI             DUAL ADDRESS ERROR HIGH
A07B 7E E0 E3           END     JMP     CONTRL

A07E 00                 INIPAT  FCB     0
A07F FF                 TESPAT  FCB     $FF
```


IC 15
IC 14
IC 13
IC 12
IC 11
IC 10
IC9
IC8
C3
C6
C5
C7
IC7
IC6
IC5
IC4
IC3
IC2
IC1
IC0
C4
R2
S2
IC 24
IC 23
IC 22
IC 21
IC 20
IC 19
R1
IC 18
IC 17
IC 16
C2
C1
C8
+
S1
UPPER 4K
LOWER 4K
WRT. PROTECT
NORMAL